Multimodal Research at CPK, Aalborg

Summary:

The IntelliMedia WorkBench (“Chameleon”)

- Campus Information System
- Multimodal Pool Trainer
  - Displays, Dialogue Walkthru
- Speech Understanding
- Vision Processing

Other (student) projects

New projects: Multimodality in Wireless Networks

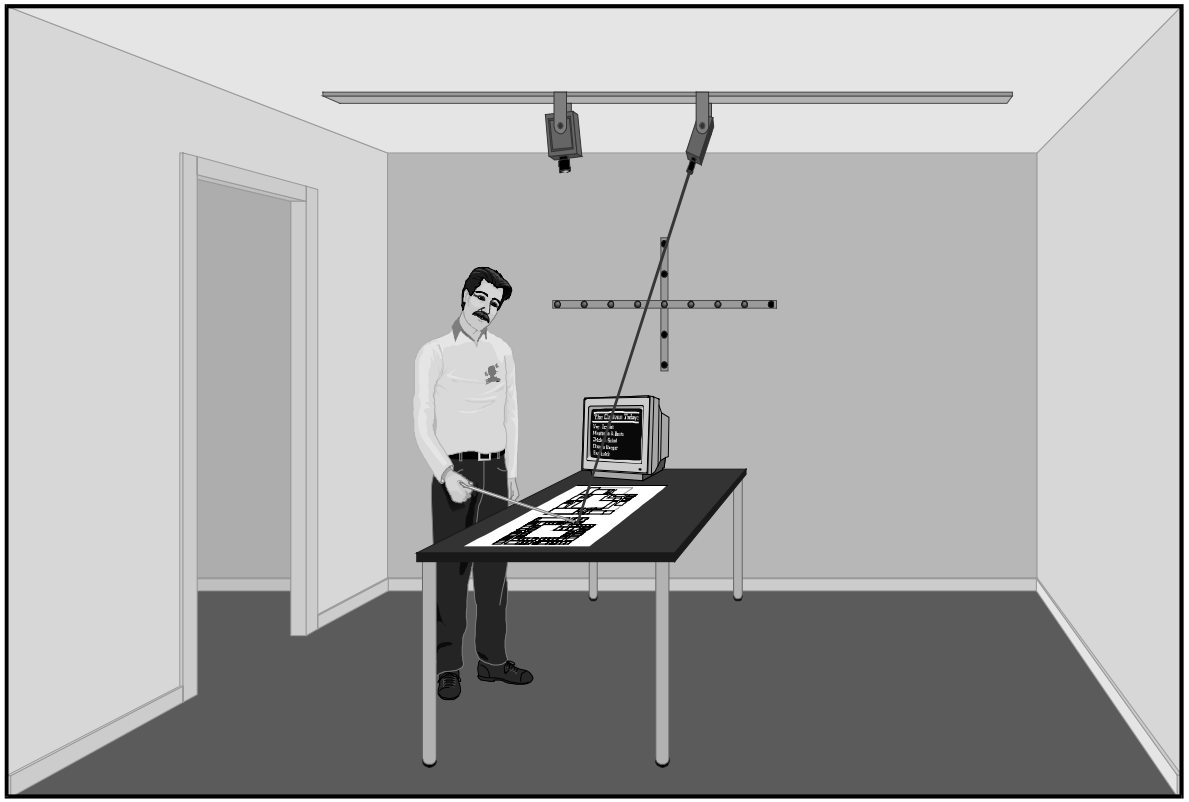
The IntelliMedia Workbench ("Chameleon")

- A suite of modules for vision and speech processing, dialogue management, laser pointing, blackboard etc.

- Purpose:
  - Cross-disciplinary collaboration at Aalborg University.
  - Exploring cross-media fusing techniques
  - Exploring multimodal human-machine interaction

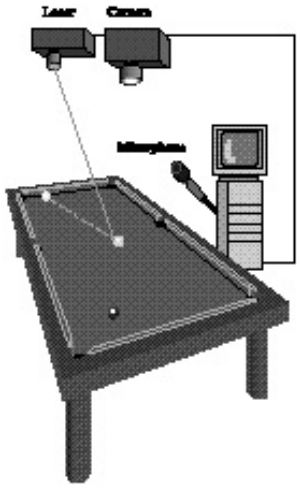
Workbench Application 1

A Campus Information System



Workbench Application 2

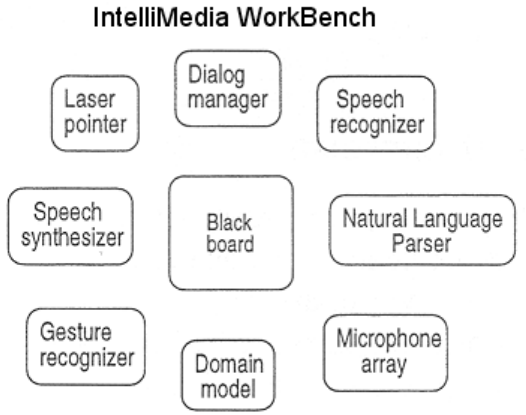
Multimodal Pool Trainer

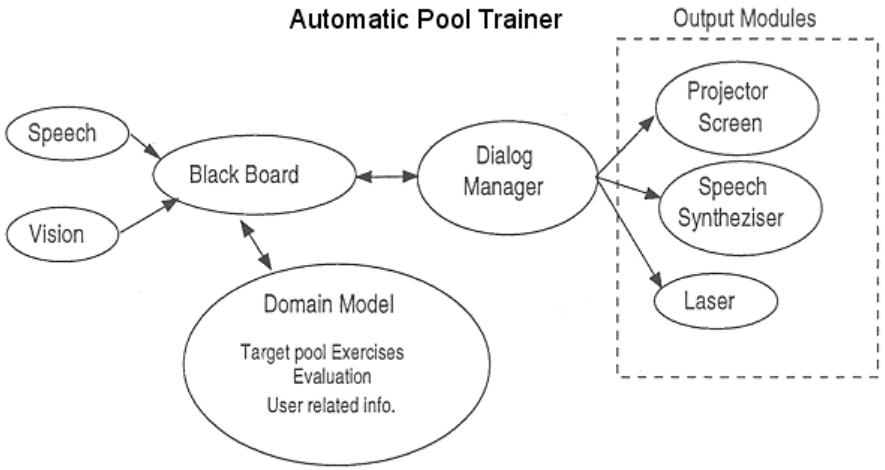


Architecture

- Initially designed WorkBench architecture (as used in The Campus Information system)

- - and as used in the Pool Trainer





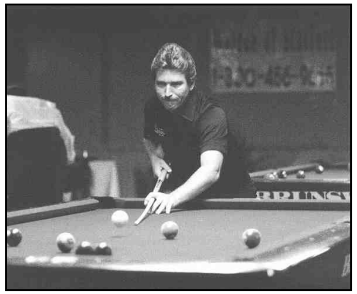
The Game of Pool

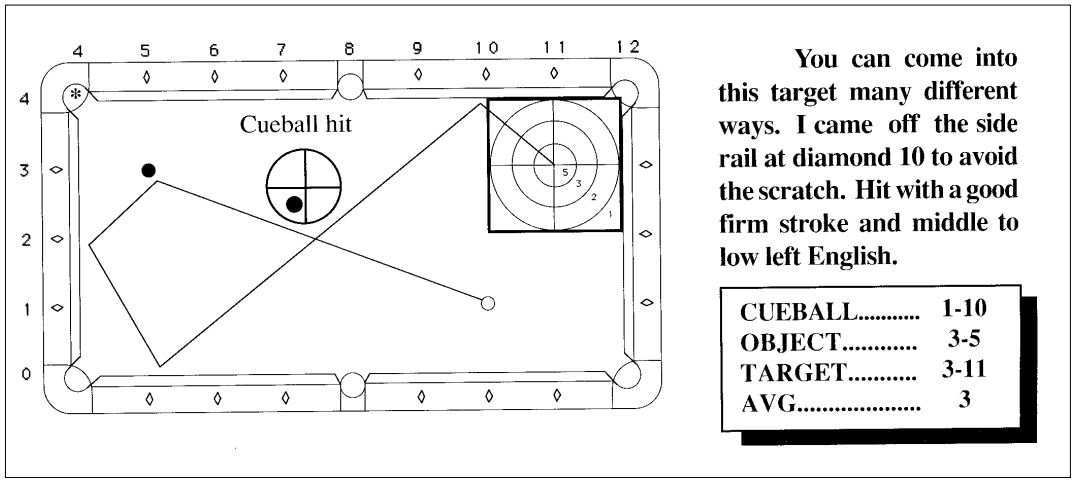
Pool is a game that requires a combination of strategic thinking as well as physical skills. Without one, the other is not of much use.

Basically, the most important requirement for any pool player is the ability to shoot the target balls into the pocket, while ensuring a good position of the cue ball for the next shot.

Target Pool

The automatic Pool Trainer is based on the widely used Target Pool system, developed by the professional pool player Kim Davenport.





Example of a typical Target Pool exercise

The computer Vision subsystem

The main functions of the image analysis subsystem are:

- Calibration and detection of the positions of the empty pool table, i.e. the rails, diamonds and pockets.
- Detection of still and moving balls placed on the pool table.
- Detection of when the cue ball is hit.
- Recording of the shot

The computer Vision subsystem

All image analysis is carried out on binary *difference images*.
This greatly reduces the time and space requirements for the image processing

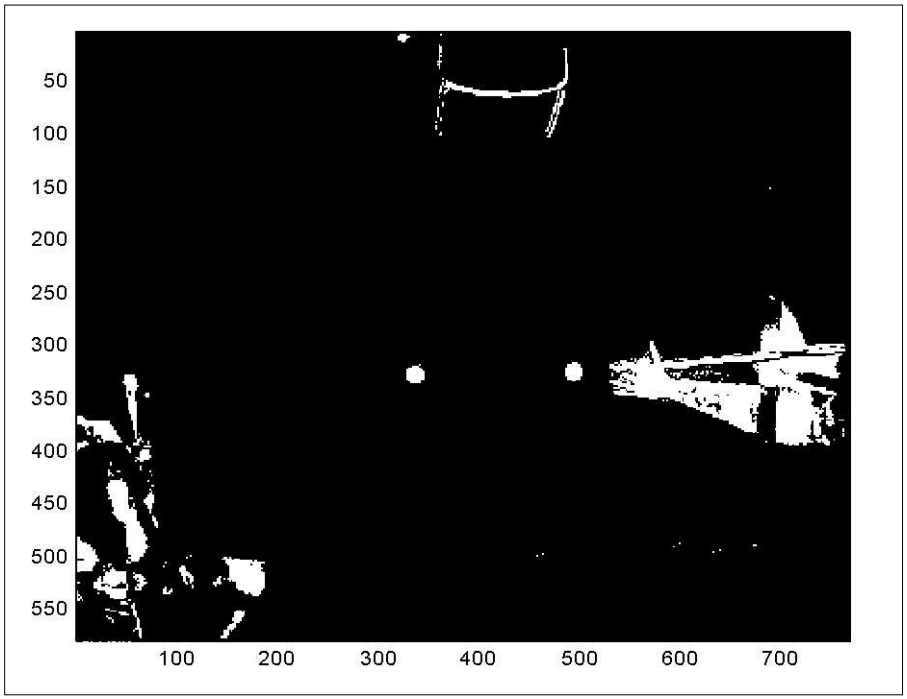
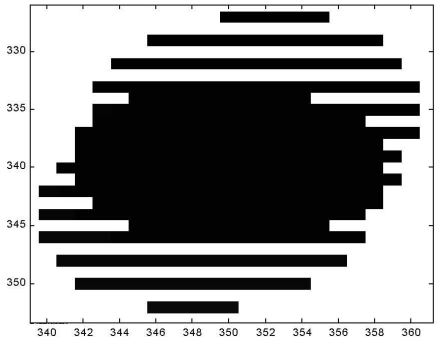
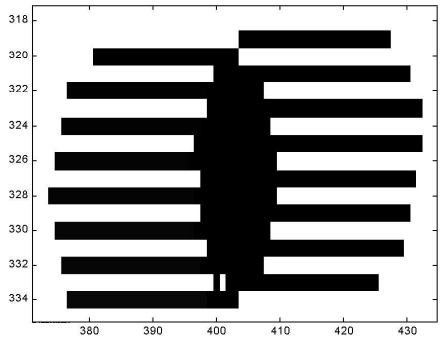


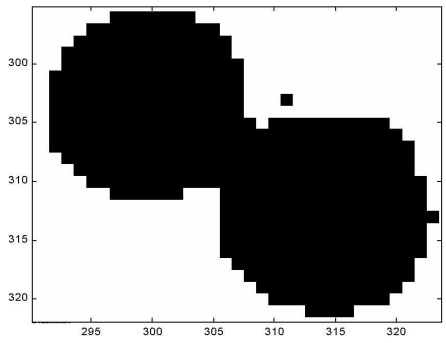
Image Processing

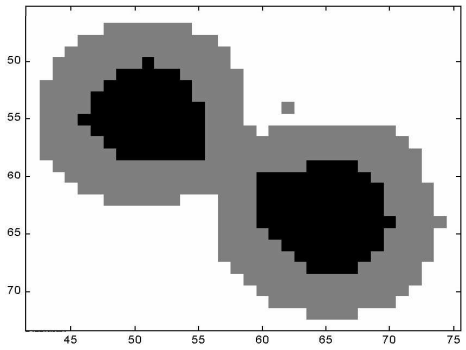
Detection of still and moving balls benefits from the distinctive patterns created by the CCD chip line scan effect.





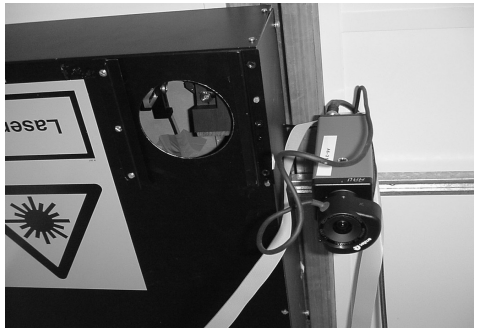
Close-lying balls are detected by removing edge pixels

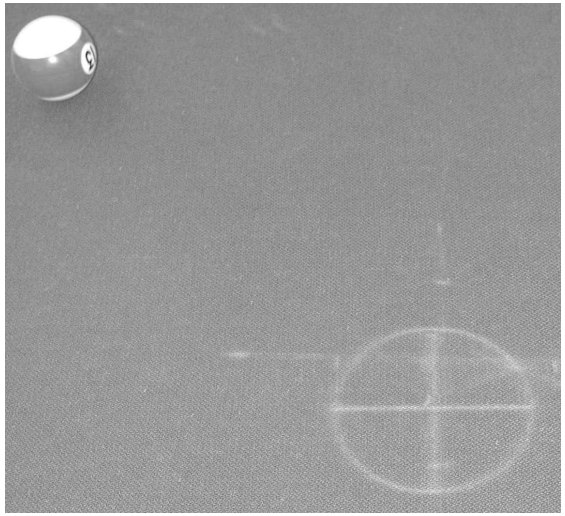


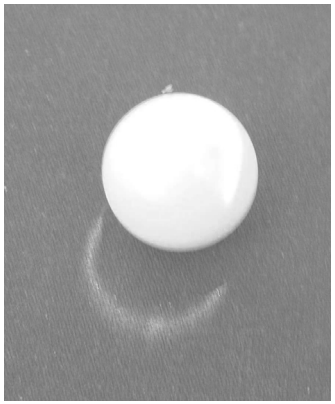


The Laser Sub-system

The laser is placed above the pool table and is used to draw the target and optimal paths of the cue- and target balls :







Mark the positions where the user must place the balls

The Speech Sub System

A number of speech recognition engines have been used a in the development of the system.

SR is presently carried out by the IBM ViaVoice recogniser. Previously, Entropics GraphVite/HAPI recognition engine have been used.

We are currently extending the interface (JSAPI) to include the public domain hvite recognition engine from Cambridge University. This will in turn allow us to support a larger number of languages, e.g. through the COST 249 Task Force reference recogniser initiative.

The Speech Sub-system

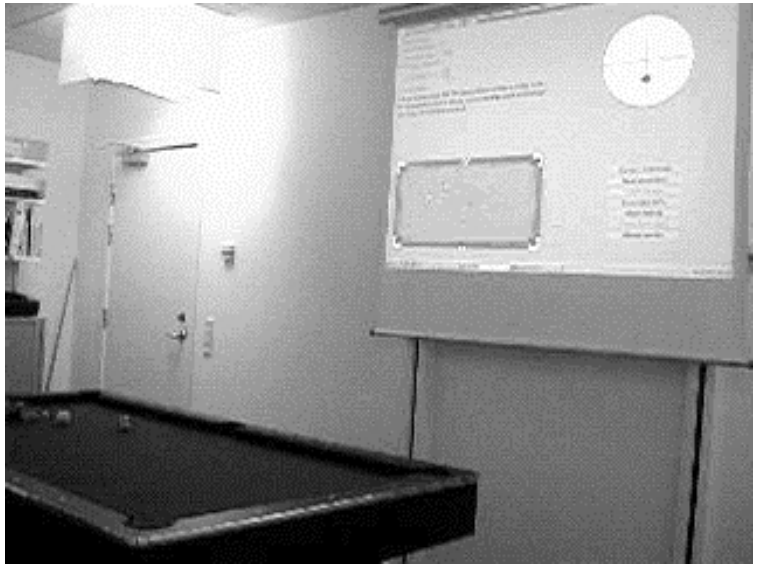
The CPK Natural language Processing Suite is presently being integrated into the trainer.

- Apart from enabling a compund feature-based language model, the suite supports a number of popular SR grammar formats, such as htk and jsgf.

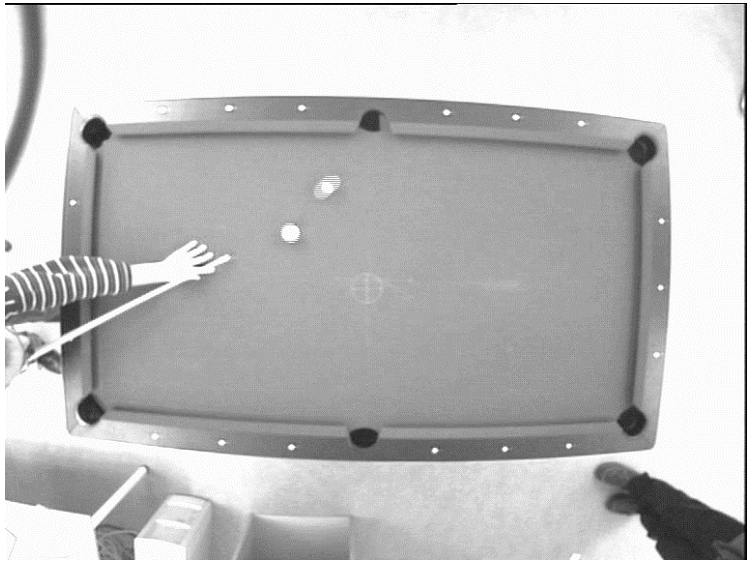
Synthetic speech output is used to achieve the high degree of flexibility needed in the spoken output

- IBMs ViaVoice and the Infovox speech synthesisers have been used, but any SAPI compliant synthesiser is supported
- Speech output is synchronized with the laser, graphics and text output to form an integrated output to the user

Examples

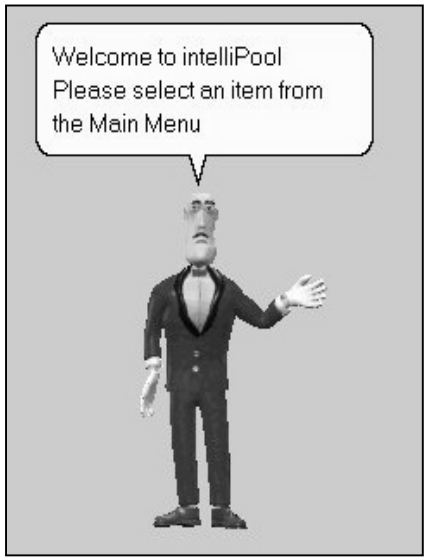


An example of a user interacting with the system



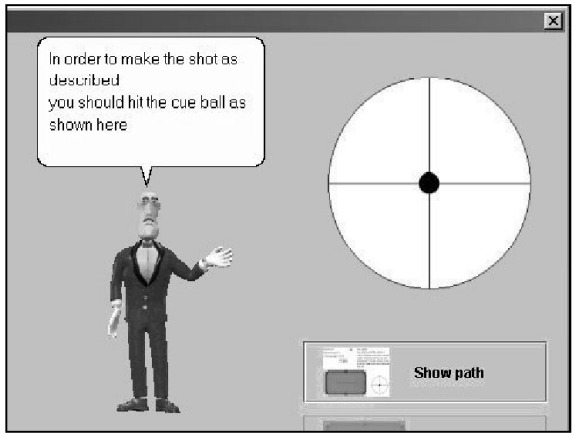
An example as seen by the system’s camera

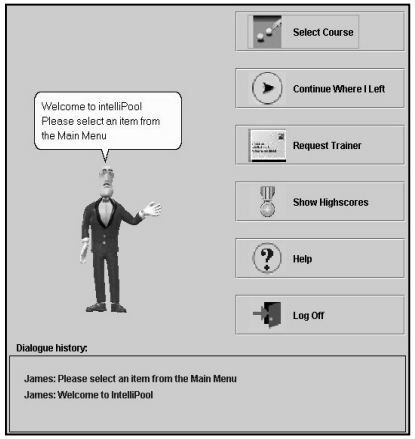
The Display Sub-system



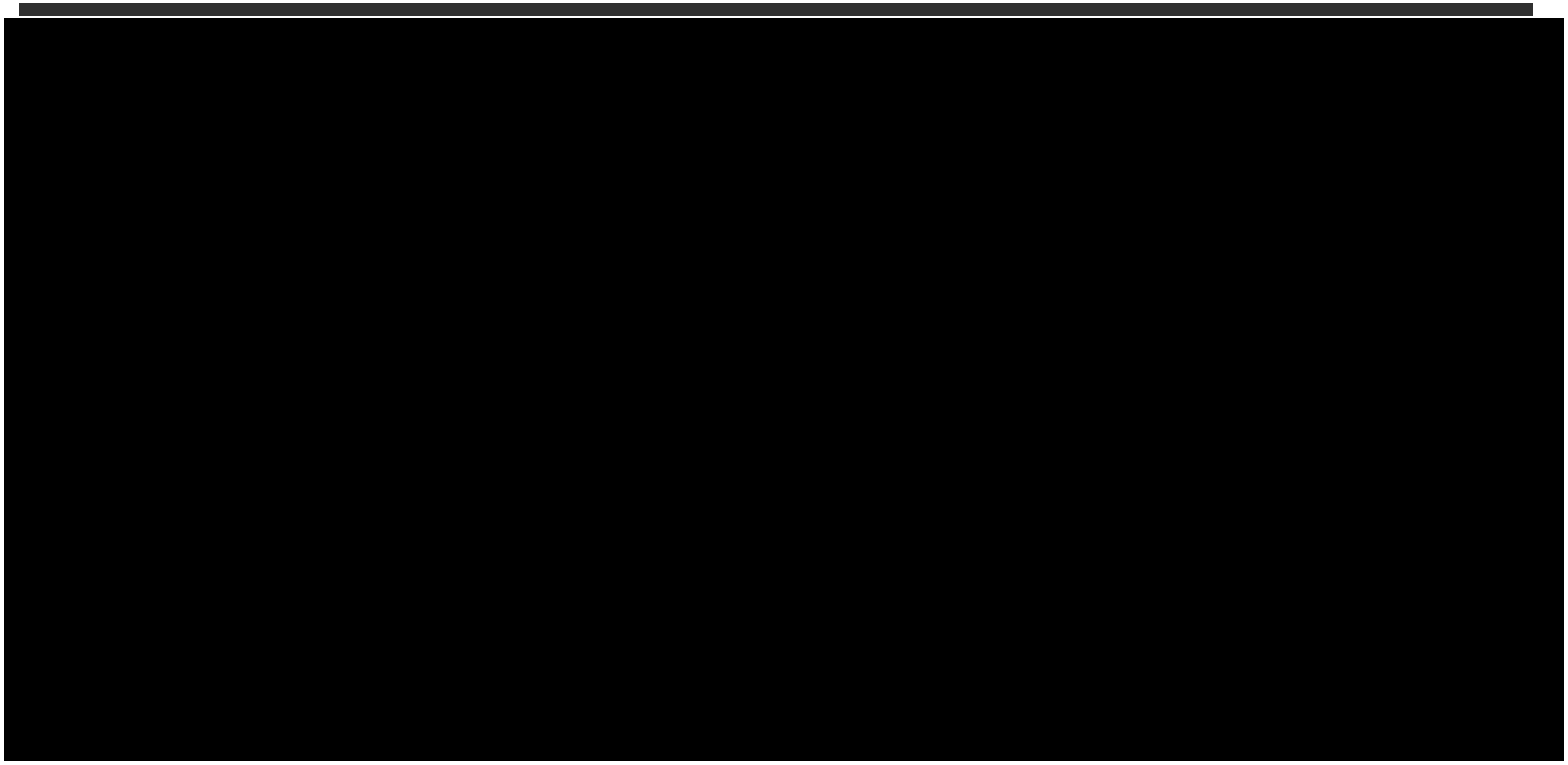
He instructs the user by speaking, pointing and moving around on the screen.

- To issue commands and receive instructions, the user communicates by speech via the interface agent James
- James is animated and understands simple commands corresponding to the menues.





Example of the interaction during an exercise



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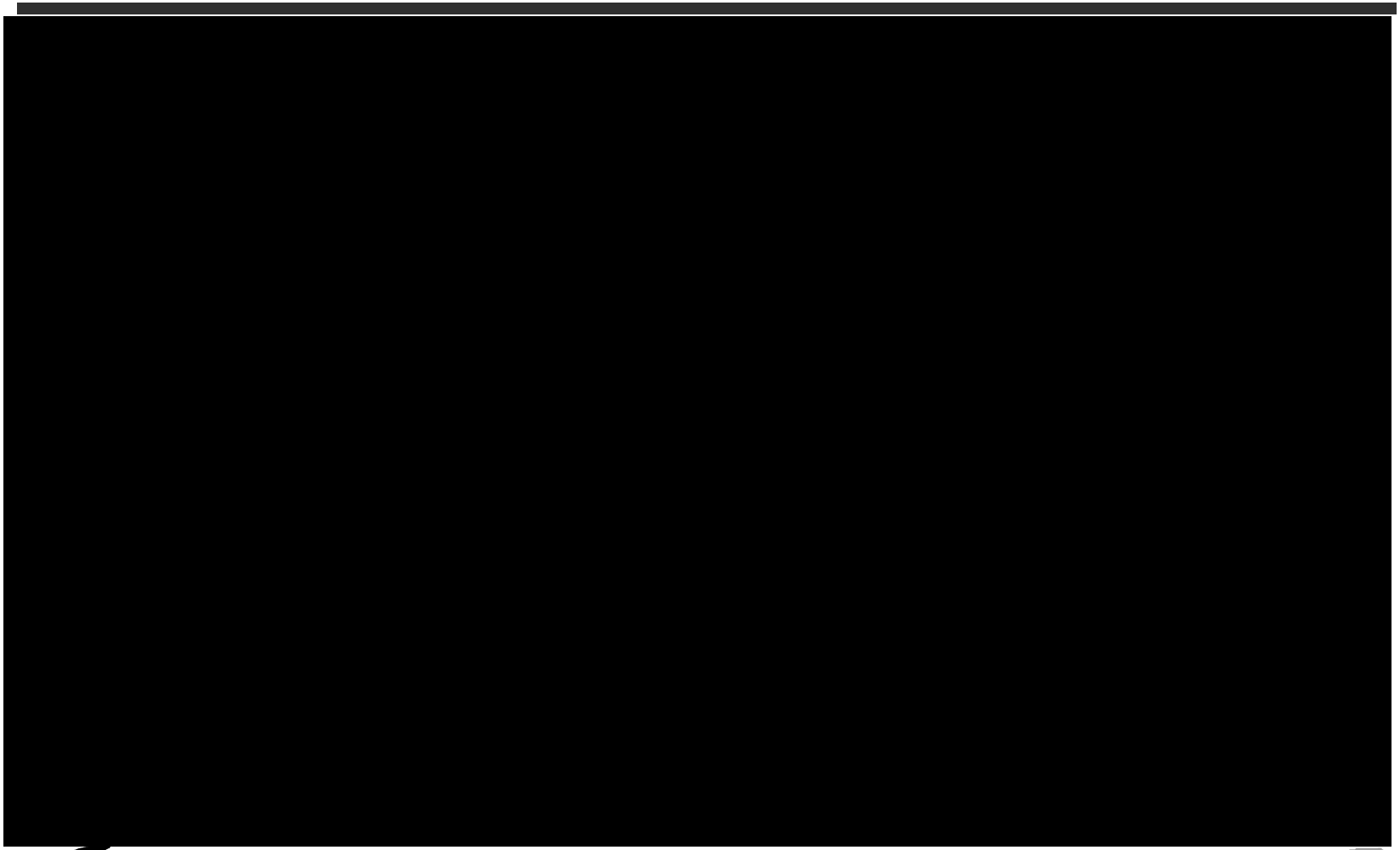

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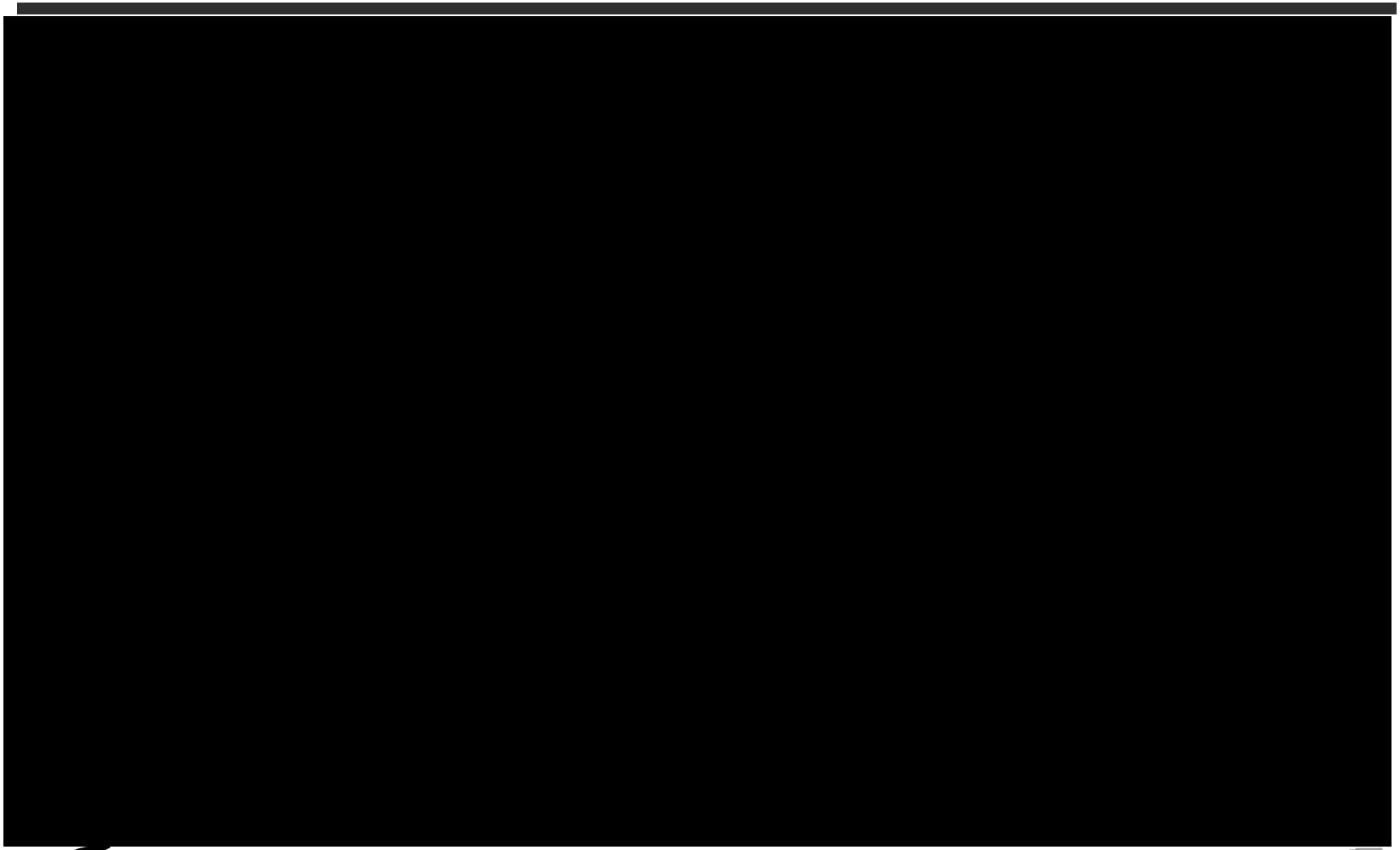


Comments to the Dialogue

The spoken dialogue can be carried out using the touch screen instead

Dialogue is most intensive during setup and evaluation of the exercise.

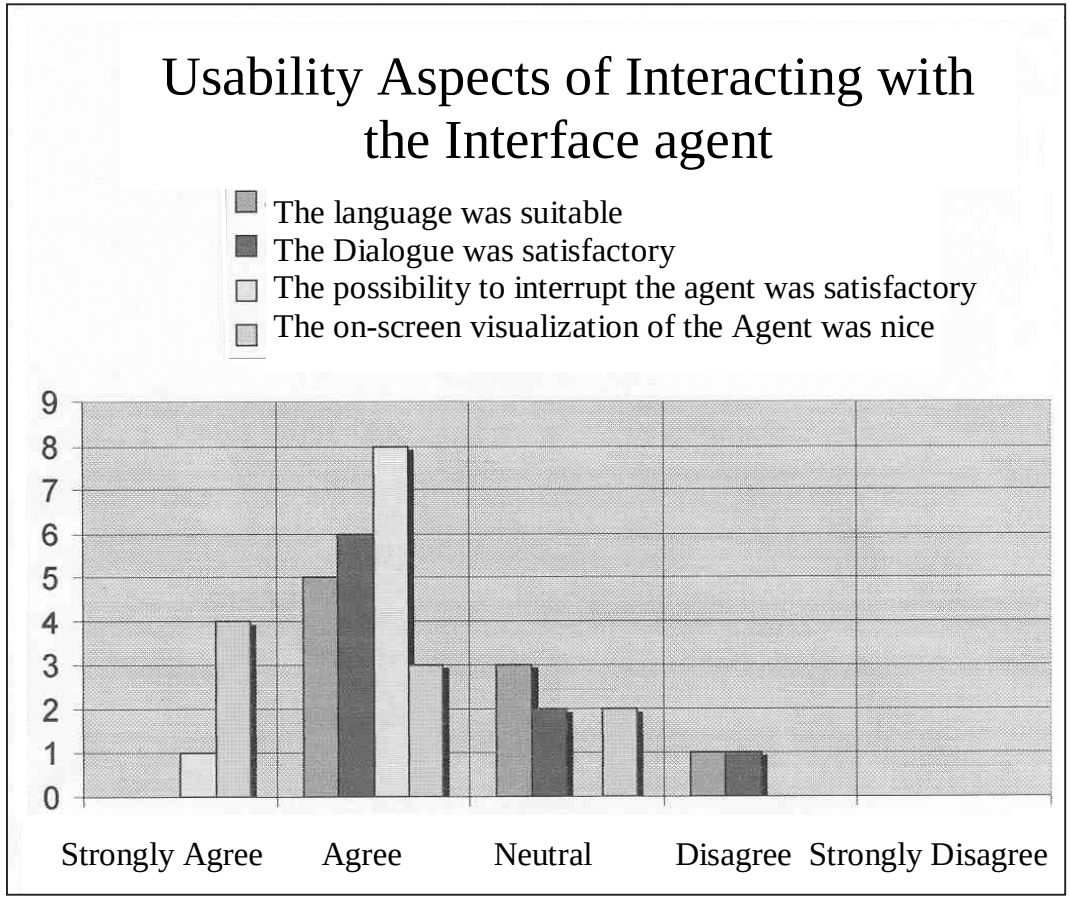
Although the example does not illustrate this, the user can take the initiative at almost any point.

An extensive help function (both about playing pool, the exercises and the system) are available

During the exercise the interaction is almost exclusively non-verbal, via physical interaction with the pool table and display on the wall-screen

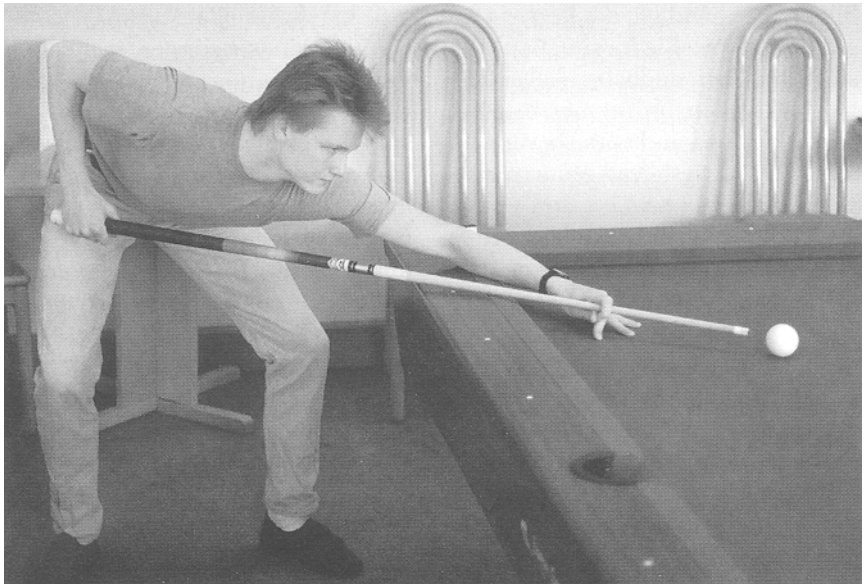
Users Tests

All users were asked to fill out a questionnaire after performing the test

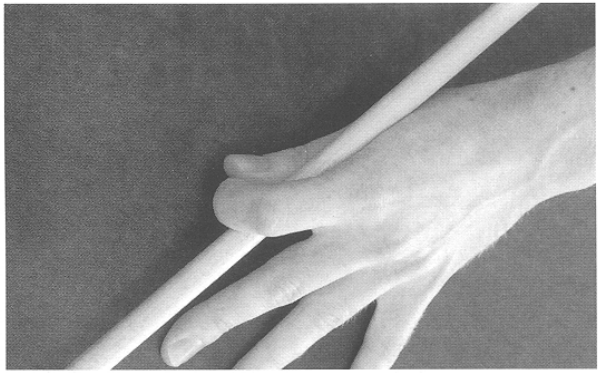


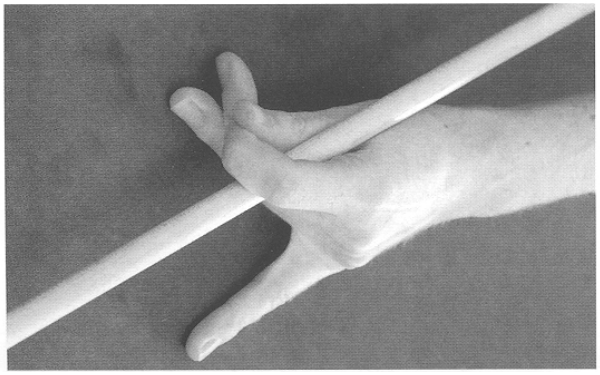
Users Tests

However, the participating pool instructors pointed out a number of issues not addressed by the system, e.g:



Stance





Bridges

Discussion

Overall, the Pool Trainer has been successful. However, some improvements are needed:

- The image analysis subsystem, although performing fast and accurate needs to be made more robust against changes in e.g. the lighting conditions, if the system were to be placed in a non-controlled environment
- If a detailed feedback of the user errors is needed, it will require knowledge about the direction and speed of the balls

Other (student) projects

Affective computing, classification of emotional speech

Recognition of hummed tunes

Enhancing Lego Mind Storm with vision

GPS-systems using touricstic (non-true scale) maps

White Board application using gesture recognition

Multimodality in Wireless Networks

- Handheld client - Remote server
- distribution: what is executing where, what is transmitted?
- Selection of modality
  - based on information type (e.g. speech is temporal, don't use it for time tables!)
  - based on situation (e.g. speech enables "eyes-free"/"hands-free" operation)
  - based on network conditions
    - is your modality (what you transmit) sensitive to package loss?
    - Is your modality sensitive sensitive delays
    - does your modality require a bandwith